MISR-CERES Narrow-to-Broadband Results

using coincident views from MISR and CERES (along track SSF) on Terra

integrates MISR spectral radiances over CERES footprint using PSF and compares with CERES broadband SW

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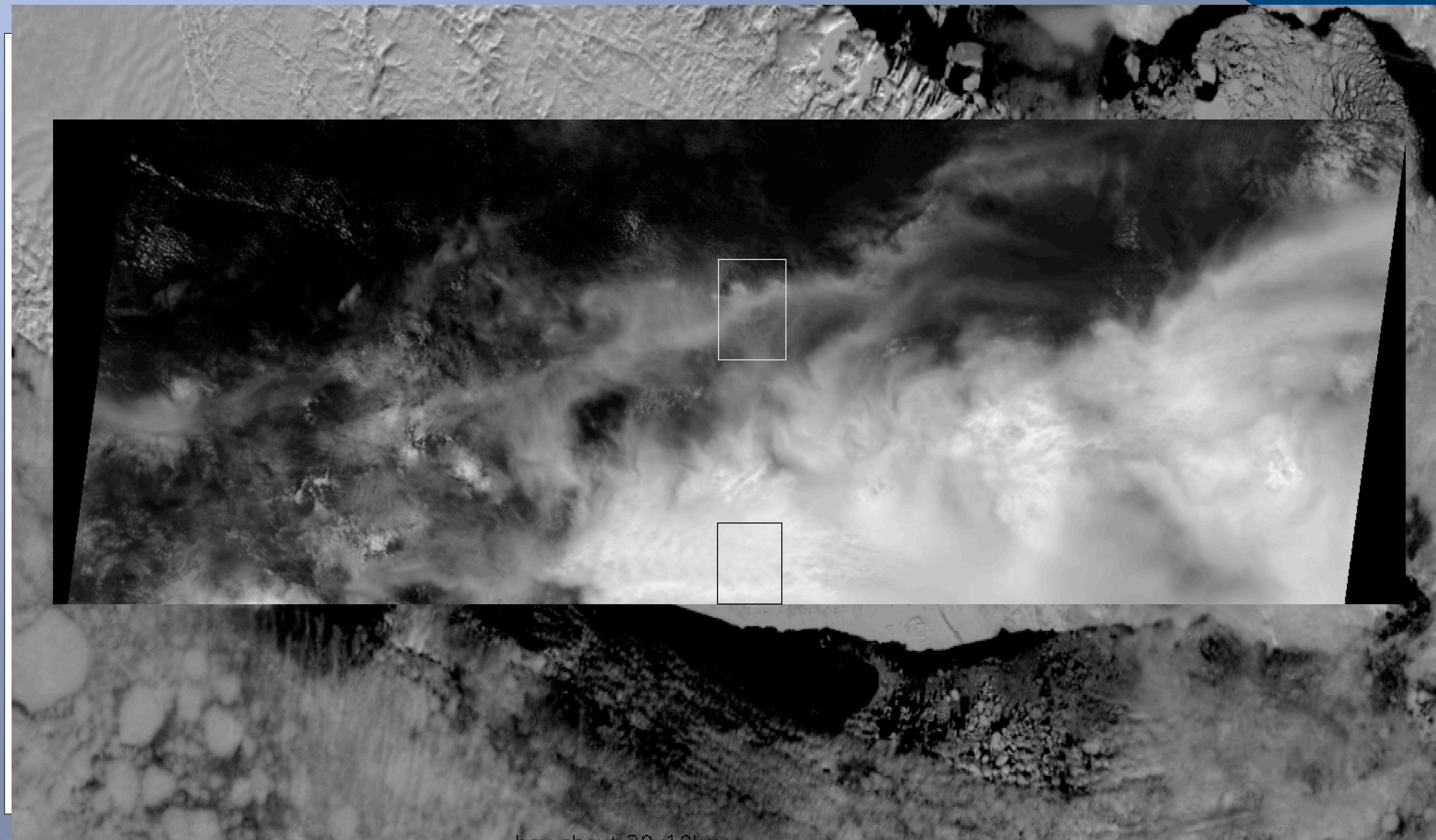
Narrow-broadband Issues

- generic single band regression
  - overall rms (camera specific)
- prospects for multi-band regression
  - lessons learned from residual outliers
    - cloud height
    - scene heterogeneity
  - likely scene candidates
  - "Information orthogonal" approach
- prospects for accurate prediction of rms error
  - magnitudes
  - good versus bad scene types
- future work

Generic MISR Single-band Results

- Overall rms, typically:
  - Camera AN r = 0.985 - 0.993, rms = ~15%, or ~10 W/m^2/sr
  - Cameras DF, AA r = 0.96 - 0.99, rms = ~20%, or ~18 W/m^2/sr
- Considerable rms differences between bands
  - rms increases with camera angle
  - blue band has highest rms error
  - outlying errors can vary considerably along orbit (non-Gaussian)
- generic rms error is **large** ~10 W/m^2/sr (seeking ≈ 3)
- *⇒ next consider multiple regression and scene type*
  - Using **"information orthogonalization"** to treat very high cross-correlation between MISR spectral bands (blue, green, red, near ir: 446, 558, 672, 866 nm)

Mulltiband Regression Residual Analysis (an example)

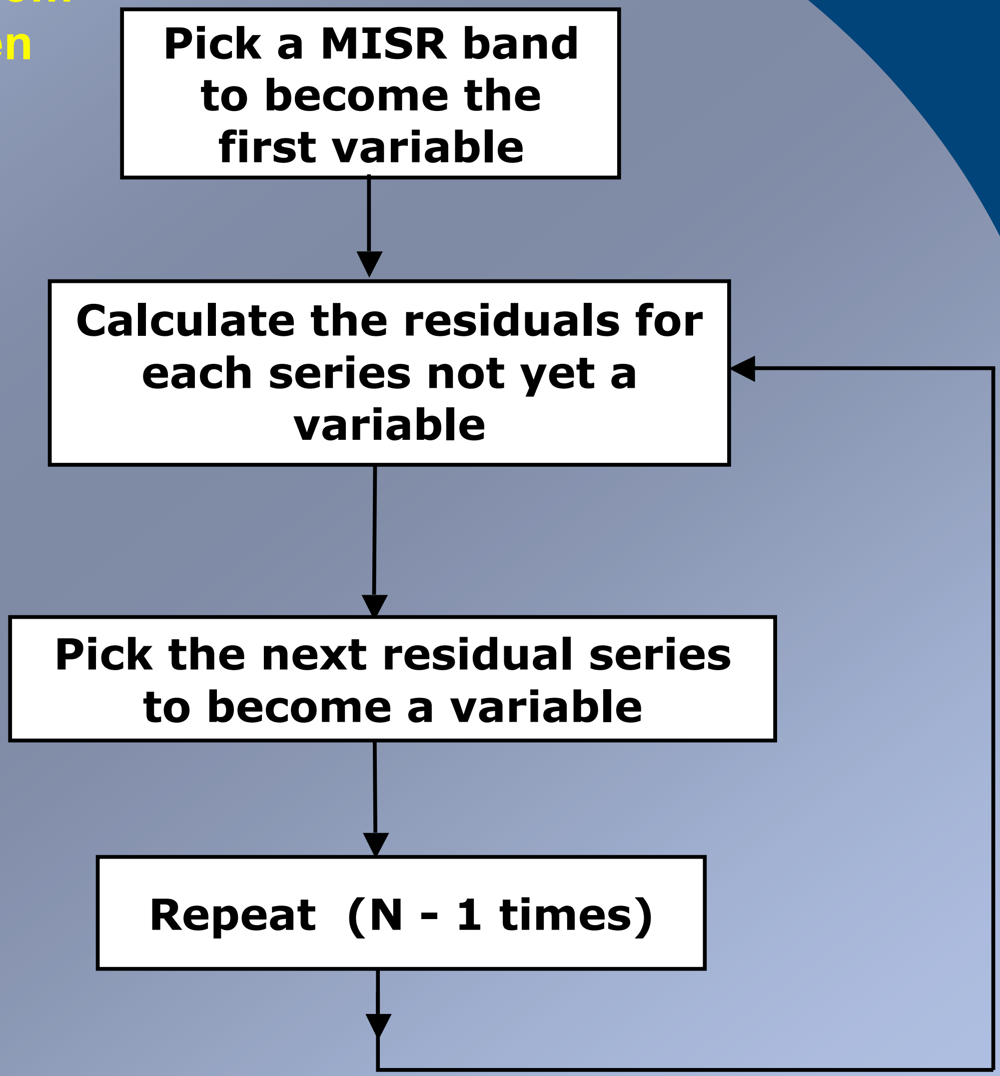


SCENE GROUPINGS CURRENTLY IN USE

```
1) all data in each band  3) for UNDEFINED scenes only
5) for snow cover only    7) for clear ocean only
9) for clear land only

11) for ocean, partly cloudy        thin liquid clouds
13) for ocean, moderately cloudy    thin liquid clouds
15) for ocean, mostly cloudy        thin liquid clouds
17) for ocean, overcast             thin liquid clouds

19) for ocean, partly cloudy        thick liquid clouds
21) for ocean, moderately cloudy    thick liquid clouds
23) for ocean, mostly cloudy        thick liquid clouds
25) for ocean, overcast             thick liquid clouds

27) for ocean, partly cloudy        thin ice clouds
29) for ocean, moderately cloudy    thin ice clouds
31) for ocean, mostly cloudy        thin ice clouds
33) for ocean, overcast             thin ice clouds

35) for ocean, partly cloudy        thick ice clouds
37) for ocean, moderately cloudy    thick ice clouds
39) for ocean, mostly cloudy        thick ice clouds
41) for ocean, overcast             thick ice clouds

43) for land, partly cloudy         thin liquid clouds
45) for land, moderately cloudy     thin liquid clouds
47) for land, overcast              thin liquid clouds

49) for land, partly cloudy         thick liquid clouds
51) for land, moderately cloudy     thick liquid clouds
53) for land, overcast              thick liquid clouds

55) for land, partly cloudy         thin ice clouds
57) for land, moderately cloudy     thin ice clouds
59) for land, overcast              thin ice clouds

61) for land, partly cloudy         thick ice clouds
63) for land, moderately cloudy     thick ice clouds
65) for land, overcast              thick ice clouds
```

Variable orthogonalization:

Subtract out successive residuals from residual series that have not yet been orthogonalized until no info left



Orthogonal Multiple Regression for scene groups & Improvement without outliers

SCENE TYPE	# PTS	CAMERA	--------COEFFICIENTS--------				$\sigma_{y.x}$	RELSIG	R_{mult}
all_scenes	2793	AN	0.510	0.406	0.197	-0.146	3.4	0.069	0.998
all_scenes	2696	AN	0.508	0.407	0.203	-0.083	2.6	0.055	0.998
snow	1151	AN	0.501	0.417	0.287	-0.141	2.5	0.059	0.998
snow	1110	AN	0.500	0.428	0.249	0.231	1.8	0.044	0.999
Clear_ocean	360	AN	0.540	0.344	0.196	0.071	0.8	0.114	0.993
Clear_ocean	352	AN	0.539	0.346	0.193	0.080	0.7	0.102	0.995
ocn_liq_pc_thin	158	AN	0.549	0.207	0.220	0.119	1.5	0.121	0.993
ocn_liq_pc_thin	154	AN	0.550	0.218	0.247	0.091	1.3	0.111	0.994
ocn_liq_mstc_thn	125	AN	0.536	-0.457	0.314	-1.413	**3.6**	0.105	0.995
ocn_liq_mstc_thn	120	AN	0.534	-0.465	0.327	-1.333	**2.8**	0.083	0.997
ocn_liq_ovrc_thn	130	AN	0.535	-0.018	0.310	-0.770	**3.6**	0.090	0.996
ocn_liq_ovrc_thn	126	AN	0.538	0.126	0.262	-0.732	**2.9**	0.072	0.997
ocn_ice_ovrc_thn	151	AN	0.546	-0.216	0.220	-1.406	2.3	0.072	0.997
ocn_ice_ovrc_thn	144	AN	0.543	-0.176	0.361	-0.672	1.5	0.051	0.999
ocn_ice_ovrc_thk	122	AN	0.532	0.167	-0.274	-0.070	2.2	0.032	0.999
ocn_ice_ovrc_thk	118	AN	0.531	0.099	-0.314	0.552	1.9	0.027	1.000
ocn_liq_modc_thn	180	DA	0.553	-0.012	0.833	-1.373	**6.4**	0.445	0.896
ocn_liq_modc_thn	178	DA	0.557	0.126	0.702	-0.351	**6.1**	0.431	0.902
ocn_liq_mstc_thn	58	DA	0.526	0.420	0.736	-2.496	**6.9**	0.365	0.931
ocn_liq_mstc_thn	57	DA	0.561	0.243	1.281	-1.483	**6.0**	0.316	0.949

2nd rows show outliers removed

(1 orbit)

Other Issues and Future Work

- Apply MISR stereo heights
  - to account for water vapor absorption
- Filter out heterogeneous scenes
  - by brightness variation and cloud height variation
- Apply to a much larger dataset
  - Have put considerable effort into speeding up our basic MISR to CERES comparison code

Also

- Need to know instrument time constant
  - to compare MISR and CERES data - footprint weighting
- Consider adding other factors: solar zenith angle, relative azimuth angle, scattering angle, ozone proxy
- Consider color indices, especially for clear land scenes

Progress Summary

- we have obtained considerable prediction improvement vs. generic scene single band
- scene heterogeneity seems (currently) to cause the greatest prediction errors
- high bright clouds should be treated as separate class
- best guess error for stratified scenes, multiple regression, $\approx 2\ W\ m^{-2}\ sr^{-1}$

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Effect of removing largest outliers

- Scene classifications used (show table) and results (show chart, **include** all scenes results & and without and with all outliers removed, use numerical output if out of time this week)
- results may be limited by remaining heterogeneous scenes

Multiple-regression for specific scene types
Effect of removing largest outliers

- Main difficulty: MISR measurements are highly correlated. (Table showing typical band cross-correlation)
- a. High x-correlations suggest that little information can be added by using more than 1 or 2 bands.
- b. ? The above not necessarily true. (Show RMS error.)
- c. Information Orthogonalization: Shows where the information is. (Show diagram + statistics example)
  - » i. ? Show example: *r* for each successive band added
  - » ii. Show example: change in coefficients versus several cameras, with & without orthogonalization (bar chart)
  - » iii. Discuss disadvantages + solution, hopefully

- or simply show the before and after: may not have enough time for lots of depth here.

Multiple-regression for specific scene types
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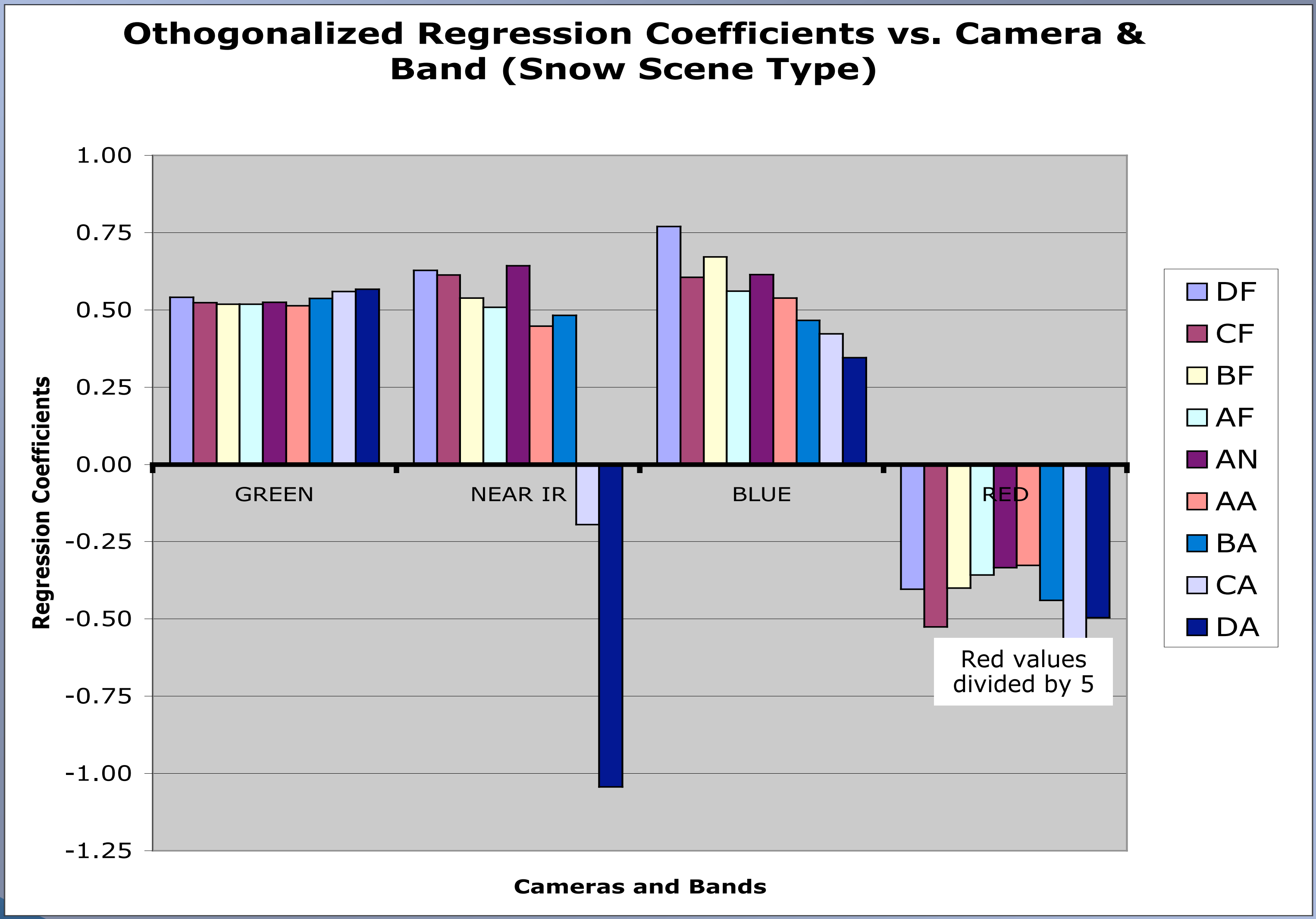
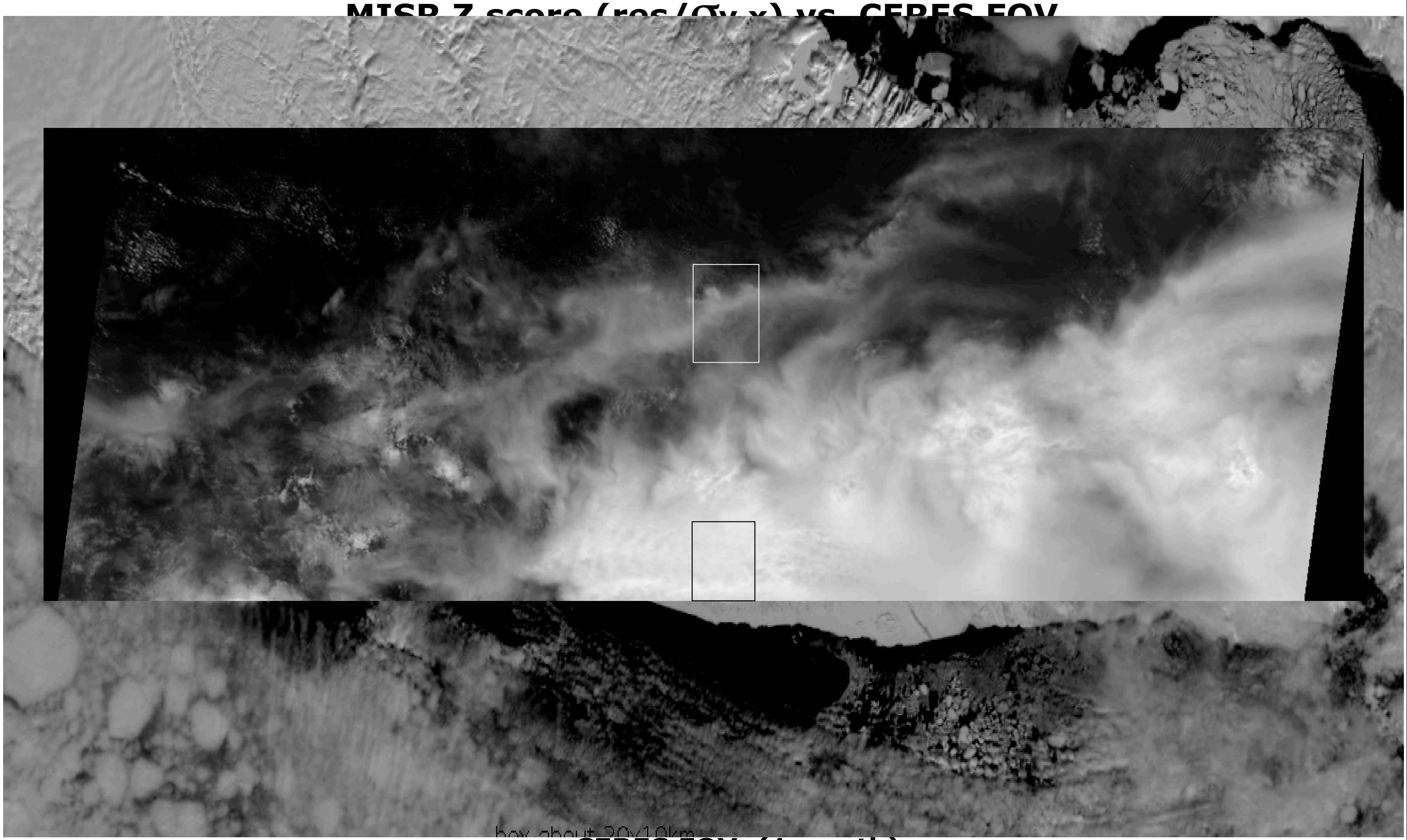
Stabilization of Regression Coefficients



Multiband Regression Residual Analysis (an example)

MISR Z score (res/σy,x) vs. CERES FOV



box about 20x10km

CERES FOV (1 swath)